

WHAT IS CLAIMED IS:

1. A printed circuit board comprising:

a metal sheet having a surface partially or totally roughed;

a dielectric film for a capacitor covering at least the roughed surface of said metal sheet;

5 a first electrically conductive layer covering the surface of said dielectric film for the capacitor;

a second electrically conductive layer formed on the surface of said first electrically conductive layer and electrically connected to an electrode of a first via for electrical connection to said first electrically
10 conductive layer; and

a resin layer provided for encapsulating an assembly made up by said metal sheet, dielectric film, the first electrically conductive layer and the second electrically conductive layer;

said first via for connection being formed on boring through said
15 resin layer until reaching said second electrically conductive layer, said first via for connection including a first electrode of a conductive member deposited therein; and

a second via for electrical connection to said metal sheet not being provided with said dielectric film for the capacitor, nor with said first
20 electrically conductive layer, nor with said second electrically conductive layer, on said metal sheet in said second via for electrical connection to said metal sheet, said second via for connection extending throughout said resin layer until reaching said metal sheet; said second via for connection including a second electrode of an electrically

25 conductive member deposited therein; said second electrode being electrically insulated from said first electrically conductive layer by an insulating member provided between said second electrode and said first electrically conductive layer.

2. The printed circuit board as defined in claim 1 wherein said dielectric film for the capacitor is formed of a film of a metal oxide.

3. The printed circuit board as defined in claim 1 wherein said first electrically conductive layer is formed of an electrically conductive resin which forms a solid electrolyte of a cathode.

4. The printed circuit board as defined in claim 3 wherein said first electrically conductive layer comprises at least one electrically conductive high molecular compound selected from the group consisting of polypyrrole, polythiophene and polyaniline.

5. The printed circuit board as defined in claim 1 wherein said second electrically conductive layer is of a double-layer structure comprised of a carbon paste layer and a silver paste layer.

6. The printed circuit board as defined in claim 1 wherein, in said second via for connection, said insulating member is formed of said resin encapsulating an assembly made up by said metal sheet, the dielectric film, the first electrically conductive layer and the second

5 electrically conductive layer; and wherein

 said resin layer abutting on said metal sheet in a region of the surface of said metal sheet surrounding the bottom of said second electrode in said second via for connection, said resin layer covering at least a portion of the lateral surface of said second electrode operating

10 for electrically insulating said second electrode from said first electrically conductive layer in the vicinity of said second via for connection.

7. The printed circuit board as defined in claim 1 wherein, in said second via for connection, said insulating member is formed by a member different from said encapsulating resin layer;

said insulating member has one surface abutting against said metal
5 sheet in a region of the surface of said metal sheet surrounding said second electrode;

the surface of said insulating member opposite to said one surface abutting against said resin surrounding said second electrode;

said insulating member covering at least a portion of the lateral
10 surface of said second electrode providing for electrical insulation between said second electrode and the region of said first electrically conductive layer lying in the vicinity of said second via for connection.

8. The printed circuit board as defined in claim 7 wherein the position of said opposite surface of said insulating member in a direction normal to said metal sheet is flush with or at a higher level than a region of the surface of said first electrically conductive layer lying in the vicinity of
5 said second via for connection.

9. The printed circuit board as defined in claim 1 wherein, in said second via for connection, said insulating member comprises a member different from said resin encapsulating the assembly made up by said metal sheet, the dielectric film, the first electrically conductive layer
5 and the second electrically conductive layer;

said insulating member has one surface abutting against said metal sheet in a region of the surface of said metal sheet surrounding said second electrode;

the surface of said insulating member opposite to said one surface
10 abutting against said resin surrounding said second electrode;

said insulating member covering at least a portion of the lateral surface of said second electrode providing for electrical insulation between said second electrode on one hand and the region of said first and second electrically conductive layers lying in the vicinity of said
15 second via for connection and the second electrically conductive layer on the other hand.

10. The printed circuit board as defined in claim 9 wherein the position of said opposite surface of said insulating member in a direction normal to said metal sheet is flush with or at a higher level than the region of the surface of said second electrically conductive layer lying in the
5 vicinity of said second via for connection.

11. The printed circuit board as defined in claim 1 wherein said second electrically conductive layer comprises a metal plating layer covering said first electrically conductive layer.

12. The printed circuit board as defined in claim 11 wherein said metal plating layer is a plating layer of at least one metal selected from the group consisting of nickel, copper and indium.

13. The printed circuit board as defined in claim 7 wherein said insulating member is formed in a region of the surface of said metal sheet in register with said second via for connection and is a resist

which becomes a mask for roughing processing of the surface of said
5 metal sheet.

14. A printed circuit board comprising:

a metal core substrate, having a surface partially or totally
roughed;

a metal oxide film covering at least the roughed surface of said
5 metal core substrate and forming a dielectric film for a capacitor;

an electrically conductive high molecular layer covering the
surface of said metal oxide film to form a cathode side solid electrolyte;

an electrically conductive paste film interposed between an
electrode of a via for cathode side connection and the surface of said
10 electrically conductive high molecular layer; and

an electrically insulating resin for encapsulating an assembly made
up by said metal core substrate, the metal oxide film, the electrically
conductive high molecular layer and the electrically conductive paste
film; wherein

15 said via for cathode side connection extending throughout said
resin until reaching said electrically conductive paste film, said via for
cathode side connection including a first electrode formed of a
conductive member deposited therein;

said via for anode side electrical connection to said metal core
20 substrate is freed of said metal oxide film and said electrically
conductive high molecular layer and is not provided with said
electrically conductive paste film, said via for anode side connection
extending throughout said resin until reaching said metal core substrate,

said via for anode side connection including a second electrode of an
25 electrically conductive member deposited therein; and wherein

in said via for anode side connection, the bottom of said resin
surrounding said second electrode abutting against said metal core
substrate; said resin charged into a space between said second electrode
and said electrically conductive high molecular layer in the vicinity of
30 said via for anode side connection providing for electrical insulation
between said second electrode and the portion of said electrically
conductive high molecular layer lying in the vicinity of said via for
anode side connection.

15. A printed circuit board comprising:

a metal core substrate, having a surface partially or totally
roughed;

a metal oxide film covering at least the roughed surface of said
5 metal core substrate and forming a dielectric film for a capacitor;

an electrically conductive high molecular layer covering the
surface of said metal oxide film to form a cathode side solid electrolyte;

an electrically conductive paste film interposed between an
electrode of a via for cathode side connection and the surface of said
10 electrically conductive high molecular layer; and

an electrically insulating resin for encapsulating an assembly made
up by said metal core substrate, the metal oxide film, the electrically
conductive high molecular layer and the electrically conductive paste
film; wherein

15 said via for cathode side connection extending throughout said

resin until reaching said electrically conductive paste film, said via for cathode side connection including a first electrode of a conductive member deposited therein;

said via for anode side electrical connection to said metal core
20 substrate is not provided with said metal oxide film, nor with the electrically conductive high molecular layer, nor with the electrically conductive paste film, said via for anode side connection extending throughout said resin until reaching said metal core substrate, said via for anode side connection including a second electrode of an electrically
25 conductive member deposited therein;

said via for anode side connection includes an insulating member having one surface abutting against said metal core substrate in a region of the surface of said metal sheet surrounding said second electrode;

30 the position of the other surface of said insulating member opposite to said one surface in a direction normal to the surface of said metal core sheet is flush with or at a higher level than the surface of said electrically conductive high molecular layer in the vicinity of said via for anode side connection, said opposite other surface of said insulating
35 member abutting against said resin surrounding said second electrode; and wherein

the portion of said insulating member covering at least a portion of the lateral surface of said second electrode provides for electrical insulation between said second electrode and said electrically
40 conductive high molecular layer in the vicinity of said via for anode side

connection.

16. The printed circuit board as defined in claim 14 wherein said insulating member comprises a resist formed in a region of the surface of said metal sheet in which said via for anode side connection is to be formed, said resist serving as a mask in the roughing processing for said
5 metal sheet; and wherein

the region of the metal core substrate in which said resist has been formed is of a height different than in a near-by region where said metal oxide film and said electrically conductive high molecular layer are formed.

17. A printed circuit board comprising:

a metal core substrate, having a surface partially or totally roughed;

a metal oxide film covering at least the roughed surface of said
5 metal core substrate and forming a dielectric film for a capacitor;

an electrically conductive high molecular layer covering the surface of said metal oxide film and forming a cathode side solid electrolyte;

a metal plating layer covering the surface of said electrically
10 conductive high molecular layer; and

an insulating resin for encapsulating an assembly made up by said metal core substrate, the metal oxide film, the electrically conductive high molecular layer and said metal plating layer; wherein

said via for cathode side connection is formed in a bore extending
15 through said resin until reaching said metal plating layer, said via for

cathode side connection including a first electrode of an electrically conductive material deposited therein;

said via for anode side electrical connection to said metal core substrate is not provided with said metal oxide film, nor with the electrically conductive high molecular layer, nor with the electrically conductive paste film, said via for anode side connection being formed by boring through said resin until reaching the metal core substrate, said via for anode side connection including a second electrode of an electrically conductive member deposited therein;

said via for anode side connection includes an insulating member having one surface abutting against said metal core substrate in a region of the surface of said metal sheet surrounding said second electrode;

the position of the other surface of said insulating member opposite to said one surface in an upstanding direction relative to the surface of said metal sheet is flush with or at a higher level than the surface of said metal plating layer in the vicinity of said via for anode side connection, said opposite other surface of said insulating member abutting against said resin surrounding said second electrode; and wherein

the portion of said insulating member covering at least a portion of the lateral surface of said second electrode provides for electrical insulation between said second electrode on one hand and said electrically conductive high molecular layer in the vicinity of said via for anode side connection and the metal plating layer on the other hand.

18. The printed circuit board as defined in claim 17 wherein said

insulating member comprises a resist formed in a region of the surface of said metal sheet in which said via for anode side connection is to be formed, said resist serving as a mask in the roughing processing for said metal sheet; and wherein

the region of the metal core substrate in which said resist has been formed has a height different than in a near-by region where said metal oxide film, said electrically conductive high molecular layer and the metal plating layer are formed.

19. The printed circuit board as defined in claim 14 wherein said electrically conductive high molecular layer is at least one electrically conductive high molecular compound selected from the group consisting of polypyrrole, polythiophene and polyaniline.

20. The printed circuit board as defined in claim 14 wherein said second electrically conductive paste film is of a double-layer structure comprised of a carbon paste layer and a silver paste layer.

21. The printed circuit board as defined in claim 17 wherein said metal plating layer is a plating layer of at least one metal selected from the group consisting of nickel, copper and indium.

22. The printed circuit board as defined in claim 14 wherein said metal core substrate is formed of aluminum, with said metal oxide film being a film of aluminum oxide.

23. The printed circuit board as defined in claim 14 wherein said metal oxide film has a thickness in a range from hundreds of pm (picometers) to tens of nm (nanometers), and said electrically conductive high molecular layer has a thickness in a range from 1 to 50 μ m.

24. A multi-layered circuit board at least one layer of which comprises the printed circuit board as defined in claim 1, an upper layer and/or a lower layer of said one layer including an insulating layer and an interconnection layer laminated in alternation with each other.

25. A semiconductor device comprising:

a semiconductor chip; and

the printed circuit board as defined in claim 1; wherein

said printed circuit board including a through-hole extending from
5 one surface to the opposite side surface of said printed circuit board,
said through-hole including a conductor formed on an inner wall surface
thereof;

said first and second electrodes, provided in respective vias for
connection on one surface of the printed circuit board, are connected
10 to first and second power supply terminals of said semiconductor chip;
signal electrodes of said one surface of said printed circuit board being
connected to associated electrodes of said semiconductor chip;

the other surface of the printed circuit board including an electrode
connected to said electrodes on said one surface by said through-hole
15 and said first and second electrodes provided in the respective vias for
connection; and wherein

the semiconductor device is connected to a mounting circuit board
on the opposite surface of the printed circuit board.

26. The semiconductor device as defined in claim 25 wherein said
semiconductor chip is bonded by flip chip bonding to the electrode on
said one surface of the printed circuit board, and wherein spherically-

shaped bumps are arranged on said other surface of the printed circuit
5 board.

27. A method for producing a printed circuit board comprising:

a step of roughing the surface of a metal sheet adapted to be a core
substrate;

a step of forming a dielectric film for a capacitor on at least the
5 roughed surface of said metal sheet;

a step of forming a first electrically conductive layer on said
dielectric film for the capacitor;

a step of forming a second electrically conductive layer in an area
on the surface of said first electrically conductive layer in register with
10 an area in which a first via for electrical connection to said first
electrically conductive layer is to be formed;

a step of boring a hole through said first electrically conductive
layer and said dielectric film for the capacitor in an area in which a
second via for electrical connection to said metal sheet is to be formed,
15 to remove said first electrically conductive layer and the dielectric film
for the capacitor to expose said metal sheet;

a step of encapsulating an assembly including said metal sheet,
said first electrically conductive layer, said dielectric film for the
capacitor and the second electrically conductive layer, formed by the
20 respective steps, with an electrically insulating resin;

a step of boring through said resin for forming said first via for
connection to expose said second electrically conductive layer, and
boring through said resin for forming said second via for connection to

expose said metal sheet; and

25 a step of depositing an electrically conductive material in a conductor pattern including said vias.

28. A method for producing a printed circuit board comprising:

 a step of forming an insulating member in a partial area on the surface of a metal sheet, as a core substrate, where electrical connection to said metal sheet is to be established;

5 a step of roughing the surface of said metal sheet as said partial area of said metal sheet is to be covered by said insulating member;

 a step of forming a dielectric film for a capacitor on the roughed surface of said metal sheet, except the area thereof covered by said insulating member, leaving said insulating member on said metal sheet;

10 a step of forming a first electrically conductive layer on said dielectric film for the capacitor leaving said insulating member on said metal sheet;

 a step of forming a second electrically conductive layer in an area of the surface of said first electrically conductive layer in which a first
15 via for electrical connection to said first electrically conductive layer is to be formed, leaving said insulating member on said metal sheet;

 a step of encapsulating an assembly including said metal sheet, said first electrically conductive layer, said dielectric layer for the capacitor and the second electrically conductive layer by said insulating
20 member, formed by the respective steps, with an electrically insulating member;

 a step of boring through said resin to form said first via for

connection to expose said second electrically conductive layer and boring through said resin and said insulating member to form said
25 second via for electrical connection to said metal sheet, to expose a portion of the surface of said metal sheet; and

a step of depositing an electrically conductive material in a conductor pattern including said vias.

29. A method for producing a printed circuit board comprising:

a step of forming an insulating member in a partial area on the surface of a metal sheet, as a core substrate, where electrical connection to said metal sheet is to be established;

5 a step of roughing the surface of said metal sheet under covering said partial area of said metal sheet by said insulating member;

a step of forming a dielectric film for a capacitor on the roughed surface of said metal sheet except the area thereof covered by said insulating member, leaving said insulating member on said metal sheet;

10 a step of forming a first electrically conductive layer on said dielectric film for the capacitor, leaving said insulating member on said metal sheet;

a step of forming a second electrically conductive layer overlying said first electrically conductive layer, leaving said insulating member
15 on said metal sheet;

a step of encapsulating an assembly including said metal member, said first electrically conductive layer and said dielectric layer for the capacitor, the second electrically conductive layer and said insulating member, formed by the respective steps, with an electrically insulating

20 resin;

a step of boring through said resin to form said first via for connection to expose said second electrically conductive layer, and boring through said resin and said insulating member to form said second via for electrical connection to said metal sheet, to expose a
25 portion of the surface of said metal sheet; and

a step of depositing an electrically conductive material in a conductor pattern including said vias.

30. The method for producing a printed circuit board as defined in claim 27 wherein said dielectric film for the capacitor is formed by a film of an oxide of a metal of said metal sheet.

31. The method for producing a printed circuit board as defined in claim 27 wherein said first electrically conductive layer is formed of an electrically conductive resin as a solid electrolyte material of a cathode.

32. The method for producing a printed circuit board as defined in claim 31 wherein said electrically conductive resin is at least one electrically conductive high molecular compound selected from the group consisting of polypyrrole, polythiophene and polyaniline.

33. The printed circuit board as defined in claim 27 wherein said second electrically conductive layer is of a double-layer structure comprised of a carbon paste layer and a silver paste layer.

34. The printed circuit board as defined in claim 29 wherein said second electrically conductive layer comprises a metal plating layer formed for covering said first electrically conductive layer.

35. The printed circuit board as defined in claim 34 wherein said metal

plating layer comprises a plating layer of at least one metal selected from the group consisting of nickel, copper and indium.

36. The printed circuit board as defined in claim 28 wherein the upper surface of said insulating member has a height, in a direction normal to said metal sheet, that is flush with or at a higher level than the region of said first electrically conductive layer in the vicinity of said insulating member.

37. The printed circuit board as defined in claim 36 wherein a step difference is provided in said metal sheet so that a region thereof provided with said insulating member is at a higher level than a near-by region where said dielectric film for the capacitor and the first electrically conductive layer are provided.

38. The printed circuit board as defined in claim 29 wherein the upper surface of said insulating member has a height, in a direction normal to the surface of said metal sheet, that is flush with or at a higher level than the region of said second electrically conductive layer in the vicinity of said insulating member.

39. The printed circuit board as defined in claim 38 wherein a step difference is provided in said metal sheet so that a region thereof provided with said insulating member is at a higher level than a near-by region where said dielectric film for the capacitor, the first electrically conductive layer and the second electrically conductive layer are provided.

40. The printed circuit board as defined in claim 28 wherein said insulating member is a resist working as a mask in the roughing

processing for the surface of said metal sheet.

41. The printed circuit board as defined in claim 27 wherein said dielectric film for capacitor has a thickness in a range from hundreds of pm (picometers) to tens of nm (nanometers).

42. The printed circuit board as defined in claim 27 wherein said first electrically conductive layer has a thickness in a range from 1 to 50 μ m (micrometers).